U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 USC 371 AND 37 CFR 1.491**	ATTORNEY DOCKET NO 401585
	U.S. APPLICATION NO. 10/088001

INTERNATIONAL APPLICATION NO. PCT/CH99/00452	INTERNATIONAL FILING DATE September 22, 1999	PRIORITY DATE CLAIMED

TITLE OF INVENTION
SCREW-TYPE INTRAOSSAL DENTAL IMPLANT

APPLICANT(S) FOR DO/EO/US
Ulrich JOOS

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371 and 37 CFR 1.491.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371 and 37 CFR 1.491.

3. ☒ This is an express request to begin national examination procedures (35 USC 371(f)).

4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).

5. ☒ A copy of the International Application as filed (35 USC 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ An English language translation of the International Application as filed (35 USC 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).

10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

11. Nucleotide and/or Amino Acid Sequence Submission
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper Copy
   c. ☐ Statement verifying identity of above copies

Items 12 to 19 below concern other document(s) or information included:

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
      ☒ Form PTO-1449
      ☒ Copies of Listed Documents
      ☒ Copy of ISR

13. ☒ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

14. ☒ A FIRST preliminary amendment.
      ☐ A SECOND or SUBSEQUENT preliminary amendment.

15. ☐ A substitute specification.

16. ☐ A change of power of attorney and/or address letter.

17. ☒ Application Data Sheet Under 37 CFR 1.76

18. ☒ Return Receipt Postcard

19. ☐ Other items or information:

U.S. APPLICATION NO. 10/088001	INTERNATIONAL APPLICATION NO. PCT/CH99/00452	ATTORNEY DOCKET NO. 401585

20. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO......................$1,040.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO...................$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO, but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..............................$740.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4).........................$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1) to (4).............................$100.00		

ENTER APPROPRIATE BASIC FEE AMOUNT=	$890.00	
Surcharge of $130.00 for furnishing the National fee or oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	13 -20=		x $ 18.00	$	
Independent Claims	1 - 3 =		x $ 84.00	$	
☐ Multiple Dependent Claim(s) (if applicable)			+$280.00	$	

TOTAL OF ABOVE CALCULATIONS=	$890.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.	$445.00	
SUBTOTAL=	$445.00	
Processing fee of **$130.00** for furnishing English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date.	$	
TOTAL NATIONAL FEE=	$445.00	
Fee for recording the enclosed assignment. The assignment must be accompanied by an appropriate cover sheet. **$40.00** per property +	$40.00	
TOTAL FEE ENCLOSED=	$485.00	
	Amount to be: refunded	$
	charged:	$

a. ☒ A check in the amount of $485.00 to cover the above fee is enclosed.

b. ☐ Please charge Deposit Account No. 12-1216 in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-1216. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

23548

PATENT TRADEMARK OFFICE

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Date: March 14, 2002

Patent National Phase Transmittal (Revised 10/18/01)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

ULRICH JOOS

Application No. Unassigned

Filed: March 14, 2002

Art Unit: Unassigned

Examiner: Unassigned

For: SCREW-TYPE INTRAOSSEOUS
DENTAL IMPLANT

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE CLAIMS:

Replace the indicated claims with:

1.   (Amended) A dental implant comprising:
a)   a bottommost implant tip located at an apex;
b)   a root part which extends to the implant tip (1), is intended to be fitted in a jawbone, and has a parabolic outer contour with the implant tip as vertex;
c)   an implant neck adjoining the root part, which extends in the coronal direction and is intended to lie inside the gingiva; and
d)   an outer thread provided on the root part, wherein
e) the root part has the parabolic outer contour along its entire length (l_{max}) and as far as a theoretical ridge line at which it adjoins the implant neck.

2.   (Amended) The dental implant as claimed in claim 1, wherein
a)   the outer thread provided on the root part has an outer contour extending parallel to the parabolic outer contour of the root part, and
b)   ends at a distance of 1 mm to 4 mm from the ridge line.

3. (Amended) The dental implant as claimed in claim 1, wherein

a) the root part at the ridge line has a maximum radius (r_{max}) extending in the radial x-direction;

b) the parabolic outer contour, placed in a cartesian system of x-y coordinates, with the implant tip positioned at the origin, follows the equation $l_y = K \cdot 4r_x^2$, where

c) l_y represents the respective ordinate value and r_x represents the associated abscissa value; and

d) the constant (K) results from the equation:
$$K = l_{max} : 4r_{max}^2.$$

4. (Amended) The dental implant as claimed in claim 3, wherein the maximum radius (r_{max}) is between 1 mm and 3 mm.

5. (Amended) The dental implant as claimed in claim 1, wherein

a) the outer thread is self-cutting;

b) the length (l_{max}) of the root part correlates with a pitch (S) of the outer thread;

c) the outer thread ends at a distance, in the range of from 1 mm to 4 mm, from the ridge line; with

d) the distance being greater as the length (l_{max}) of the root part increases.

6. (Amended) The dental implant as claimed in claim 5, wherein the length (l_{max}) of the root part and the pitch (S) of the outer thread, given a maximum radius (r_{max}) = 2 mm, correlate with one another as follows:

Length (l_{max})of root part (2) [mm]	Pitch (S) [mm]
6	0.65
8	1
10	1
14	1
16	1

7. (Amended) The dental implant as claimed in claim 1, wherein the outer thread includes thread teeth,

a) the thread teeth at the root part extend in the y- direction, and have a height (g_h) of about 0.3 mm; and

b) the thread teeth in the x-direction, have a length (g_l) in the range of from 0.25 mm to 0.5 mm.

8. (Amended) The dental implant as claimed in claim 7, wherein

a) the maximum radius is 2 mm;

b) the length (g_l) of the thread teeth decreases as the length (l_{max}) of the root part (2) increases; and

c) the outer thread with its thread teeth has the following values:

Length (l_{max}) of root part [mm]	Height (g_h) of thread teeth [mm]	Length (g_l) of thread teeth [mm]
6	0.3	0.4
8	0.3	0.4
10	0.3	0.3
14	0.3	0.25
16	0.3	0.25

9. (Amended) The dental implant as claimed in claim 1, wherein

a) the implant is made of biocompatible material; and

b) the root part has a rough surface which is plasma-coated or ceramic-coated or is treated chemically, electrochemically, mechanically or by laser.

10. (Amended) The dental implant as claimed in claim 1, wherein the implant neck

a) is made of titanium, a titanium-based alloy or another biocompatible metal or its alloy and is polished; or

b) is coated with ceramic, glass ceramic, ceramic-like material, hydroxyapatite, plastic or metal.

11. (Amended) The dental implant as claimed in 1, wherein

a) measured in the y-direction, the implant neck has a height (h) in the range of from 1 mm to 3 mm; and

b) the implant neck is cylindrical or is widened or narrowed in a trumpet shape or conically in the coronal direction.

Add the following claims:

12. (New) The dental implant as claimed in claim 4, wherein the maximum radius is from about 1.5 mm to about 2 mm.

3

13. (New) The dental implant as claimed in claim 9, wherein the biocompatible material comprises titanium-based alloys, metals, metal alloys, ceramic, glass ceramic, ceramic-like material or plastic.

INSERT THE FOLLOWING ABSTRACT:

ABSTRACT

The screw-type intraossal dental implant has a bottommost implant tip that is located in the apical area and comprises a root part which extends up to said implant tip and which is intended for insertion into a jaw bone. The implant neck extending up to the coronal area is placed on the root part and is intended for being placed inside the gingivae. The outer thread on the root part is preferably self-cutting. The invention is characterized in that the root part comprises an essentially parabolic outer contour with the implant tip serving as the vertex. The inventive outer contour makes it possible to obtain an improved primary stability and guarantees, to a great extent, the long-term success of the implant.

REMARKS

The foregoing Amendment corrects translational errors and conforms the claims to United States practice. No new matter is added.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

ULRICH JOOS

Application No. Unassigned

Filed: March 14, 2002

For: SCREW-TYPE INTRAOSSEOUS
DENTAL IMPLANT

Art Unit: Unassigned

Examiner: Unassigned

AMENDMENTS TO CLAIMS MADE
VIA PRELIMINARY AMENDMENT

Amendments to existing claims:

1.   (Amended) A dental implant ~~with~~ comprising:

a)   a bottommost implant tip ~~(1)~~ located at ~~the~~ an apex;

b)   a root part ~~(2)~~ which extends to the implant tip (1), is intended to be fitted in a jawbone, and has a parabolic outer contour ~~(A)~~ with the implant tip ~~(1)~~ as vertex;

c)   an implant neck adjoining the root part ~~(2), an implant neck (3)~~ which extends in the coronal direction and is intended to lie inside the gingiva; and

d)   an outer thread ~~(4)~~ provided on the root part ~~(2),~~ wherein ~~characterized in that~~

e)   the root part ~~(2)~~ has the parabolic outer contour ~~(A)~~ along its entire length (l_{max}) and as far as a theoretical ridge line ~~(5)~~ at which it adjoins the implant neck ~~(3)~~.

2.   (Amended) The dental implant as claimed in claim 1, ~~characterized in that~~ wherein

a)   the outer thread provided on the root part ~~(2)~~ has an outer contour extending parallel to the parabolic outer contour ~~(A)~~ of the root part ~~(2)~~, and

b)   ends at a distance of 1 mm to 4 mm from the ridge line ~~(5)~~.

3.   (Amended) The dental implant as claimed in claim 1 ~~or 2, characterized in that~~ wherein

a)   the root part ~~(2)~~ at the ridge line ~~(5)~~ has ~~the~~ a maximum radius (r_{max}) extending in the radial x-direction;

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b) the parabolic outer contour (A), placed in a cartesian system of x-y coordinates, with the implant tip (1) positioned at the origin, follows the equation $l_y = K \cdot 4r_x^2$, where

c) l_y represents the respective ordinate value and r_x represents the associated abscissa value; and

d) the constant (K) results from the equation:
$$K = l_{max} : 4r_{max}^2.$$

4. (Amended) The dental implant as claimed in claim 3, ~~characterized in that~~ wherein the maximum radius (r_{max}) is between 1 mm and 3 mm~~, preferably lying in the range of from 1.5 mm to 2 mm~~.

5. (Amended) The dental implant as claimed in ~~one of claims~~ claim 1 ~~through 4~~, ~~characterized in that~~ wherein

a) the outer thread (4) is self-cutting;

b) the length (l_{max}) of the root part (2) correlates with ~~the~~ a pitch (S) of the outer thread (4);

c) the outer thread (4) ends at a distance, in the range of from 1 mm to 4 mm, from the ridge line (5); with

d) the distance being greater as the length (l_{max}) of the root part (2) increases.

6. (Amended) The dental implant as claimed in claim 5, ~~characterized in that~~ wherein the length (l_{max}) of the root part (2) and the pitch (S) of the outer thread (4), given a maximum radius (r_{max}) = 2 mm, correlate with one another as follows:

Length (l_{max}) of root part (2) [mm]	Pitch (S) [mm]
6	0.65
8	1
10	1
14	1
16	1

7. (Amended) The dental implant as claimed in ~~one of claims~~ claim 1 ~~through 6~~, ~~characterized in that~~ wherein the outer thread (4) ~~with its~~ includes thread teeth (40) ~~has the following values:~~.

a) the thread teeth at the root part (2), ~~and extending~~ extend in the y- direction, ~~the thread teeth (40)~~ and have a height (g_h) ~~in the region~~ of about 0.3 mm; and

A2

b)   the thread teeth in the x-direction, ~~the thread teeth (40)~~ have a length (g_l) in the range of from 0.25 mm to 0.5 mm.

8.   (Amended) The dental implant as claimed in claim 7, ~~characterized in that~~ wherein

a)   the maximum radius is 2 mm;

~~a~~b)   the length (g_l) of the thread teeth ~~(40) is smaller~~ decreases as the length (l_{max}) of the root part (2) increases; and

~~b~~c)   the outer thread ~~(4)~~ with its thread teeth ~~(40)~~ has, ~~given a maximum radius (r_{max}) = 2 mm,~~ the following values:

Length (l_{max}) of root part [mm]	Height (g_h) of thread teeth [mm]	Length (g_l) of thread teeth [mm]
6	0.3	0.4
8	0.3	0.4
10	0.3	0.3
14	0.3	0.25
16	0.3	0.25

9.   (Amended) The dental implant as claimed in ~~one of claims~~ claim 1 ~~through 8~~, ~~characterized in that~~ wherein

a)   the implant is made of biocompatible material ~~having suitable stability properties, for example titanium, titanium-based alloys, other metals, their alloys, ceramic, glass-ceramic, ceramic-like material or plastic~~; and

b)   the root part ~~(2)~~ has a rough surface which is plasma-coated or ceramic-coated or is treated chemically, electrochemically, mechanically or by laser.

10. (Amended) The dental implant as claimed in ~~one of claims~~ claim 1 ~~through 9~~ ~~characterized in that~~ wherein the implant neck ~~(3)~~

a)   is made of titanium, a titanium-based alloy or another biocompatible metal or its alloy and is polished; or

b)   is coated with ceramic, glass ceramic, ceramic-like material, hydroxyapatite, plastic or metal.

11. (Amended) The dental implant as claimed in ~~one of claims~~ claim 1 ~~through 10~~, ~~characterized in that~~ wherein

a) measured in the y-direction, the implant neck (3) has a height (h) in the range of from 1 mm to 3 mm; and

b) the implant neck (3) is cylindrical or is widened or narrowed in a trumpet shape or conically in the coronal direction.

Please add the following claims:

12. (New) The dental implant as claimed in claim 4, wherein the maximum radius is from about 1.5 mm to about 2 mm.

13. (New) The dental implant as claimed in claim 9, wherein the biocompatible material comprises titanium-based alloys, metals, metal alloys, ceramic, glass ceramic, ceramic-like material or plastic.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

ULRICH JOOS

Art Unit: Unassigned

Application No. Unassigned

Examiner: Unassigned

Filed: March 14, 2002

For: SCREW-TYPE INTRAOSSEOUS
        DENTAL IMPLANT

PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1.   A dental implant comprising:

a)   a bottommost implant tip located at an apex;

b)   a root part which extends to the implant tip (1), is intended to be fitted in a jawbone, and has a parabolic outer contour with the implant tip as vertex;

c)   an implant neck adjoining the root part, which extends in the coronal direction and is intended to lie inside the gingiva; and

d)   an outer thread provided on the root part, wherein

e) the root part has the parabolic outer contour along its entire length (l_{max}) and as far as a theoretical ridge line at which it adjoins the implant neck.

2.   The dental implant as claimed in claim 1, wherein

a)   the outer thread provided on the root part has an outer contour extending parallel to the parabolic outer contour of the root part, and

b)   ends at a distance of 1 mm to 4 mm from the ridge line.

3.   The dental implant as claimed in claim 1, wherein

a)   the root part at the ridge line has a maximum radius (r_{max}) extending in the radial x-direction;

b)   the parabolic outer contour, placed in a cartesian system of x-y coordinates, with the implant tip positioned at the origin, follows the equation $l_y = K \cdot 4r_x^2$, where

c) l_y represents the respective ordinate value and r_x represents the associated abscissa value; and

d)   the constant (K) results from the equation:

$K = l_{max} : 4r_{max}^2$.

B1

4. The dental implant as claimed in claim 3, wherein the maximum radius (r_{max}) is between 1 mm and 3 mm,

5. The dental implant as claimed in claim 1, wherein
a) the outer thread is self-cutting;
b) the length (l_{max}) of the root part correlates with a pitch (S) of the outer thread;
c) the outer thread ends at a distance, in the range of from 1 mm to 4 mm, from the ridge line; with
d) the distance being greater as the length (l_{max}) of the root part increases.

6. The dental implant as claimed in claim 5, wherein the length (l_{max}) of the root part and the pitch (S) of the outer thread, given a maximum radius (r_{max}) = 2 mm, correlate with one another as follows:

Length (l_{max})of root part (2) [mm]	Pitch (S) [mm]
6	0.65
8	1
10	1
14	1
16	1

7. The dental implant as claimed in claim 1, wherein the outer thread includes thread teeth,
a) the thread teeth at the root part extend in the y- direction, and have a height (g_h) of about 0.3 mm; and
b) the thread teeth in the x-direction, have a length (g_l) in the range of from 0.25 mm to 0.5 mm.

8. The dental implant as claimed in claim 7, wherein
a) the maximum radius is 2 mm;
b) the length (g_l) of the thread teeth decreases as the length (l_{max}) of the root part (2) increases; and
c) the outer thread with its thread teeth has the following values:

Length (l_{max}) of root part [mm]	Height (g_h) of thread teeth [mm]	Length (g_l) of thread teeth [mm]
6	0.3	0.4
8	0.3	0.4
10	0.3	0.3
14	0.3	0.25
16	0.3	0.25

9. The dental implant as claimed in claim 1, wherein

a) the implant is made of biocompatible material; and

b) the root part has a rough surface which is plasma-coated or ceramic-coated or is treated chemically, electrochemically, mechanically or by laser.

10. The dental implant as claimed in claim 1, wherein the implant neck

a) is made of titanium, a titanium-based alloy or another biocompatible metal or its alloy and is polished; or

b) is coated with ceramic, glass ceramic, ceramic-like material, hydroxyapatite, plastic or metal.

11. The dental implant as claimed in claim 1, wherein

a) measured in the y-direction, the implant neck has a height (h) in the range of from 1 mm to 3 mm; and

b) the implant neck is cylindrical or is widened or narrowed in a trumpet shape or conically in the coronal direction.

12. The dental implant as claimed in claim 4, wherein the maximum radius is from about 1.5 mm to about 2 mm.

13. The dental implant as claimed in claim 9, wherein the biocompatible material comprises titanium-based alloys, metals, metal alloys, ceramic, glass ceramic, ceramic-like material or plastic.

Screw-type intraosseous dental implant

Field of application of the invention

The present invention relates to a dental implant which
is intended to be fitted in the jawbone and which has a
thread on its outside. To this extent, the implant
according to the invention differs generically from
blade and cylinder implants as the other forms of
intraosseous dental implants. In particular, the
invention concerns the outer geometry of the implant,
the measurement ratios of the implant body, and the
characteristics of the outer thread, with the object of
improving both primary and secondary stability and of
thereby guaranteeing the long-term success of fitted
implants.

Prior art

Although this invention concerns dental implants, the
shorter form "implant" will be used hereinafter for the
sake of brevity. An overview of the implant forms
commonly used in dentistry is given by H. Spiekermann
in "Implantologie, Farbatlanten der Zahnmedizin"
published by Georg Thieme Verlag Stuttgart and New
York, 1994, vol. 10, page 15. Here, a differentiation
is made between blade, cylinder and screw implants. The
blade implants which may possibly be advantageous for
very specific applications are not considered at all.
The cylinder implants have a cylindrical body which is
either continuous or stepped. The root part can have
openings for better bone integration, and the implant
tip lying at the apical end has the shape of a
semisphere or a rounded summit. The root part has a
rough or profiled surface produced by material
application or removal. The implant neck or head is in
most cases smooth.

The screw implants have an outer thread extending at

least over most of the root part. Their implant bodies are likewise cylindrical with a semispherical, rounded, frustoconical or parabolic implant tip (see US 4,626,214). Slightly conical forms are also known (see US 4,713,003). The implant necks are in most cases also cylindrical at the transition from the root part, whereas in the coronal direction the heads taper conically, widen in a trumpet shape or have an external polygon.

The basically cylindrical shape of the root part has proven not best suited for obtaining the desired postoperative primary stability of the fitted implant. Moreover, the lifetime of the implants is in many cases inadequate: the fitted implant loosens early after just a few years. Investigations revealed that this early loosening is caused by bone resorption around the fitted implant, which is attributable to insufficient introduction of force to the bone via the existing implant forms. Bone expansions of between 1000 and 4000 microstrains are defined as relevant to remodeling. Values below 1000 microstrains are considered inadequate and result in reduced mineralization and formation of connective tissue. Values above 4000 microstrains are considered excessive and result in bone resorption (see Barbier, L. et al.: Finite element analysis of nonaxial versus axial loading of oral implants in the mandible of the dog, in J. Oral Rehabil. 1998, 25(11):847-858).

Object of the invention
In view of these shortcomings of the dental implants known to date, it is an object of the invention to propose an implant form which contributes to increasing the primary stability of fitted implants so that the implant is immediately able to bear loads, both during the postoperative work involved in attaching the superstructures and also during use by the patient.

Immediate ability to bear loads signifies the primary stability achieved immediately after implantation. However, it will be appreciated that in some cases it is advantageous to wait several days of the main wound-healing phase before actual loading of the implant. Moreover, an optimized implant form is intended to maintain the natural introduction of force into the bone, comparable to that in a real tooth, and thereby to guarantee the long-term success to a greater extent.

Summary of the invention

The dental implant has a bottommost implant tip located at the apex and a root part which extends to the implant tip and is intended to be fitted in the jawbone. Adjoining the root part there is the implant neck which extends in the coronal direction and, in the implanted state, comes to lie inside the gingiva. At least over some of the root part, the implant is provided with an outer thread, which can be self-cutting. The main feature is that the root part has a principally parabolic outer contour with the implant tip as vertex.

The description given below relates to preferred illustrative embodiments of the invention.

The root part and the implant neck adjoin each other on a theoretical ridge line, the root part having the maximum length l_{max} extending in the axial y-direction. At the ridge line, the root part has the maximum radius r_{max} extending in the radial x-direction. Placed in a cartesian system of x-y coordinates, and with the implant tip positioned at the origin of this system, the parabolic outer contour follows the equation

$l_y = K \cdot 4r_x^2$, with:

l_y as the respective ordinate value;

r_x as the associated abscissa value; and

K   as the constant resulting from the equation

$$K = l_{max} : 4 r_{max}^2.$$

The maximum radius r_{max} is between 1.0 mm and 3.0 mm; it preferably lies in the range of from 1.5 mm to 2.0 mm. The maximum length l_{max} of the root part correlates with the pitch of the outer thread, the latter ending at a distance from the ridge line. The distance is preferably 1.0 mm to 4.0 mm. This distance is defined by the thickness of the cortical zone on the marginal bone and by the length of the implant. In order to guarantee an optimum introduction of force into the bone in this area, the distance of the outer thread from the ridge line becomes greater as the length of the root increases. In addition, the distance contributes to excluding the very critical entry of bacteria into the implant bed.

At the root part, and extending in the y-direction, the thread teeth have a height in the region of 0.3 mm; and, extending in the x-direction, a length in the range of from 0.25 mm to 0.5 mm. The length of the thread teeth decreases as the maximum length of the root part increases.

The implant is made of biocompatible material having suitable stability properties. Examples of these are titanium, titanium-based alloys, other metals or metal alloys, ceramic, glass ceramic or ceramic-like materials, and biocompatible plastics. The root part has a rough surface which is, for example, plasma-coated or ceramic-coated, or has been treated, for example, chemically, electrochemically, mechanically or by laser. An implant neck made of titanium or a titanium-based alloy is polished. The implant neck can also be coated with ceramic or with ceramic-like material or with hydroxyapatite. Measured in the y-direction, the implant neck has a height in the region

of 2.0 mm and is cylindrical or widened or narrowed in
a trumpet shape or conically in the coronal direction.
The dental implant can be used either as a one-phase or
two-phase implant.

5   Brief description of the attached drawings

Figure 1   shows a front view of an implant according to
           the invention;

Figure 2   shows the implant according to Figure 1 in a
           system of x-y coordinates; and

10 Figure 3   shows an enlargement of the detail X from
           Figure 1.

Embodiment

There follows a detailed description of an illustrative
15 embodiment of the dental implant according to the
invention, with reference to the attached drawings.

At the very bottom of the implant is the apically
situated implant tip 1 to which the root part 2 extends
20 from the coronal direction, which root part 2 is
intended to be fitted in the jawbone. Adjoining the top
of the root part 2, at the theoretical ridge line 5, is
the implant neck 3 which extends in the coronal
direction and is intended to lie inside the gingiva.
25 From the implant tip 1 to a point below the ridge line
5, the root part 2 is provided with an outer thread 4
which is preferably self-cutting and has the pitch S.
The outer thread 4 ends at a distance below the ridge
line 5; the distance is preferably in the range of from
30 1.0 mm to 4.0 mm. The root part 2 has a substantially
parabolic outer contour A with the implant tip 1 as
vertex.

The following dimensions can be defined on the implant:
35 l   → total length, for example 12.0 mm, extending in
           the axial y-direction, on the ordinate axis;
l_{max}→ part of the total length l and maximum length of
           the root part 2;

h → part of the total length l and height of the
implant neck 3;

r_{max} → maximum radius of the root part 2 at the ridge
line 5, extending in the radial x-direction, on

5   the abscissa axis;

d → nominal diameter of the implant, which is derived
from $2 \cdot r_{max}$;

g_h → height of the thread teeth 40 of the outer thread
4 on the root part 2, extending in the y-

10   direction;

g_l → length of the thread teeth 40 in the x- direction.

If the implant is placed with its parabolic outer
contour A in a cartesian system of x-y coordinates and

15 the implant tip 1 is positioned in this case at the
origin of the system of coordinates, the outer contour
A follows the equation $l_y = K \cdot 4r_x^2$. Here represent:

l_y → the respective ordinate value for forming the
outer contour A;

20 r_x → the abscissa value associated with the ordinate
value l_y, and

K → the constant which results from the equation
$K = l_{max} : 4r_{max}^2$.

25 The maximum radius r_{max} is between 1.0 mm and 3.0 mm,
preferably lying in the range of from 1.5 mm to 2.0 mm.
Thus, assuming for example that r_{max} = 2.0 mm (nominal
diameter of the implant d = 4.0 mm), this gives the
following values for the constant K and for the

30 equations for determining the ordinate values l_y and
abscissa values r_x of the outer contour A:

Length l_{max} of root part [mm]	l_y ; r_x	Constant K
6	$l_y = K \cdot 4r_x^2$	0.375
8	$l_y = K \cdot 4r_x^2$	0.500
10	$l_y = K \cdot 4r_x^2$	0.625
12	$l_y = K \cdot 4r_x^2$	0.750
14	$l_y = K \cdot 4r_x^2$	0.875

16	$l_y = K \cdot 4r_x^2$	1.000

The maximum length l_{max} of the root part 2 correlates with the pitch S of the outer thread (4).

Thus, assuming for example that r_{max} = 2.0 mm (nominal diameter of the implant d = 4.0 mm) and assuming maximum lengths l_{max}, this gives the following relations for the pitch (S) of the outer thread 4:

Length l_{max} of root part [mm]	Pitch (S) [mm]
6	0.65
8	1.00
10	1.00
14	1.00
16	1.00

The outer thread (4) at the root part (2) with its thread teeth (40) has the following values, for example:
- extending in the y-direction, a height g_h of the thread teeth 40 in the region of 0.3 mm; and
- extending in the x-direction, a length g_l of the thread teeth 40 in the range of from 0.25 mm to 0.5 mm.

The length g_l of the thread teeth 40 decreases as the maximum length l_{max} of the root part 2 increases.

Thus, assuming for example r_{max} = 2.0 mm (nominal diameter of the implant d = 4.0 mm), this gives the following values for the outer thread 4 with its thread teeth 40:

Length l_{max} of root part [mm]	Height g_h of thread teeth [mm]	Length g_l of thread teeth [mm]
6	0.30	0.40

8	0.30	0.40
10	0.30	0.30
14	0.30	0.25
16	0.30	0.25

The implant is made of biocompatible material having suitable stability properties. Examples are titanium,

5   titanium-based alloys, other metals, their alloys, ceramic, glass ceramic or ceramic-like materials, and biocompatible plastics. The root part 2 has a rough surface which, for example, is plasma-coated or ceramic-coated or is treated, for example, chemically,

10   electrochemically, mechanically or by laser. An advantageous surface structure for the root part 2 is the subject of the invention in PCT publication WO 99/13700. The implant neck 3 can be made of titanium, a titanium-based alloy, another biocompatible metal or

15   alloy and will then advantageously be polished. The implant neck 3 could be coated with ceramic, glass ceramic, ceramic-like material, hydroxyapatite, plastic or metal.

20   The implant neck 3 has, in the y-direction, a height h in the region of, for example, 2.0 mm. It is cylindrical or widens or narrows in a trumpet shape or conically in the coronal direction.

Patent Claims

1. A dental implant with:
    a) a bottommost implant tip (1) located at the apex;
    b) a root part (2) which extends to the implant tip (1), is intended to be fitted in a jawbone, and has a parabolic outer contour (A) with the implant tip (1) as vertex;
    c) adjoining the root part (2), an implant neck (3) which extends in the coronal direction and is intended to lie inside the gingiva; and
    d) an outer thread (4) provided on the root part (2),
    characterized in that
    e) the root part (2) has the parabolic outer contour (A) along its entire length (l_{max}) and as far as a theoretical ridge line (5) at which it adjoins the implant neck (3).

2. The dental implant as claimed in claim 1, characterized in that
    a) the outer thread provided on the root part (2) has an outer contour extending parallel to the parabolic outer contour (A) of the root part (2), and
    b) ends at a distance of 1 mm to 4 mm from the ridge line (5).

3. The dental implant as claimed in claim 1 or 2, characterized in that
    a) the root part (2) at the ridge line (5) has the maximum radius (r_{max}) extending in the radial x-direction;
    b) the parabolic outer contour (A), placed in a cartesian system of x-y coordinates, with the implant tip (1) positioned at the origin, follows the equation $l_y = K \cdot 4r_x^2$, where

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c) l_y represents the respective ordinate value and r_x represents the associated abscissa value; and

d) the constant (K) results from the equation:

K = l_{max} : $4r_{max}^2$.

4. The dental implant as claimed in claim 3, characterized in that the maximum radius (r_{max}) is between 1 mm and 3 mm, preferably lying in the range of from 1.5 mm to 2 mm.

5. The dental implant as claimed in one of claims 1 through 4, characterized in that
a) the outer thread (4) is self-cutting;
b) the length (l_{max}) of the root part (2) correlates with the pitch (S) of the outer thread (4);
c) the outer thread (4) ends at a distance, in the range of from 1 mm to 4 mm, from the ridge line (5); with
d) the distance being greater as the length (l_{max}) of the root part (2) increases.

6. The dental implant as claimed in claim 5, characterized in that the length (l_{max}) of the root part (2) and the pitch (S) of the outer thread (4), given a maximum radius (r_{max}) = 2 mm, correlate with one another as follows:

Length (l_{max})of root part (2) [mm]	Pitch (S) [mm]
6	0.65
8	1
10	1
14	1
16	1

7. The dental implant as claimed in one of claims 1 through 6, characterized in that the outer thread

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(4) with its thread teeth (40) has the following values:

a) at the root part (2), and extending in the y-direction, the thread teeth (40) have a height (g_h) in the region of 0.3 mm; and

b) in the x-direction, the thread teeth (40) have a length (g_l) in the range of from 0.25 mm to 0.5 mm.

8. The dental implant as claimed in claim 7, characterized in that

a) the length (g_l) of the thread teeth (40) is smaller as the length (l_{max}) of the root part (2) increases; and

b) the outer thread (4) with its thread teeth (40) has, given a maximum radius (r_{max}) = 2 mm, the following values:

Length (l_{max}) of root part [mm]	Height (g_h) of thread teeth [mm]	Length (g_l) of thread teeth [mm]
6	0.3	0.4
8	0.3	0.4
10	0.3	0.3
14	0.3	0.25
16	0.3	0.25

9. The dental implant as claimed in one of claims 1 through 8, characterized in that

a) the implant is made of biocompatible material having suitable stability properties, for example titanium, titanium-based alloys, other metals, their alloys, ceramic, glass ceramic, ceramic-like material or plastic; and

b) the root part (2) has a rough surface which is plasma-coated or ceramic-coated or is treated chemically, electrochemically, mechanically or by laser.

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10. The dental implant as claimed in one of claims 1 through 9, characterized in that the implant neck (3)

a) is made of titanium, a titanium-based alloy or another biocompatible metal or its alloy and is polished; or

b) is coated with ceramic, glass ceramic, ceramic-like material, hydroxyapatite, plastic or metal.

11. The dental implant as claimed in one of claims 1 through 10, characterized in that

a) measured in the y-direction, the implant neck (3) has a height (h) in the range of from 1 mm to 3 mm; and

b) the implant neck (3) is cylindrical or is widened or narrowed in a trumpet shape or conically in the coronal direction.

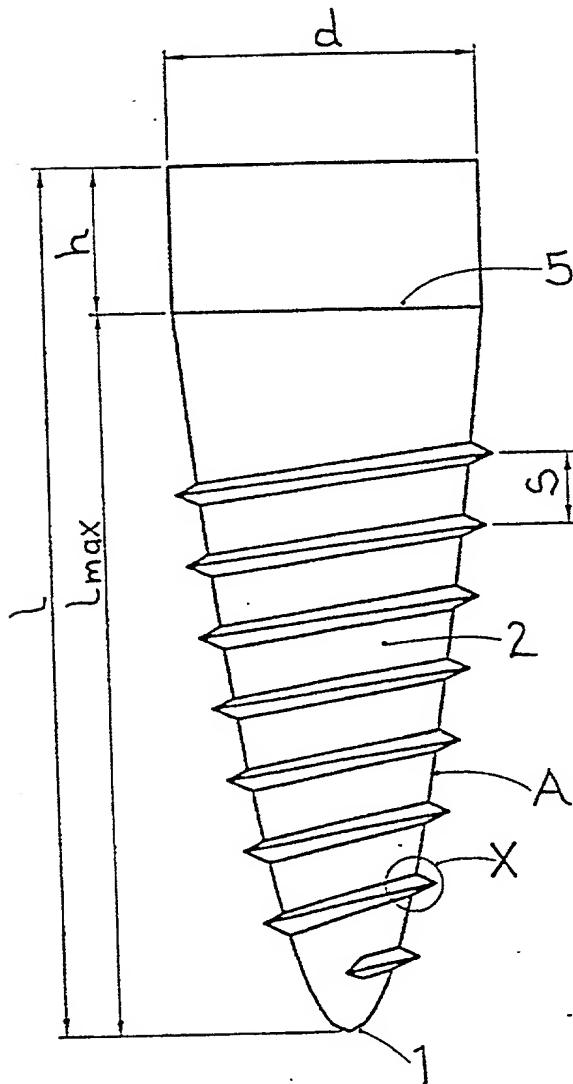AMENDED SHEET

Title: SCREW-TYPE INTRAOSSAL DENTAL IMPLANT
Inventors: Ulrich JOOS
Atty Docket No.: 401585
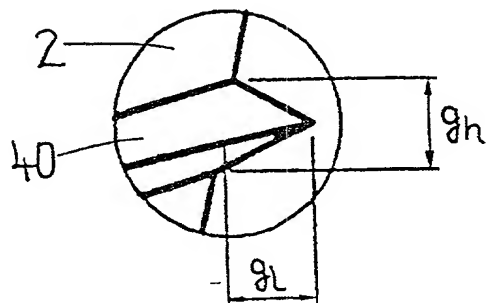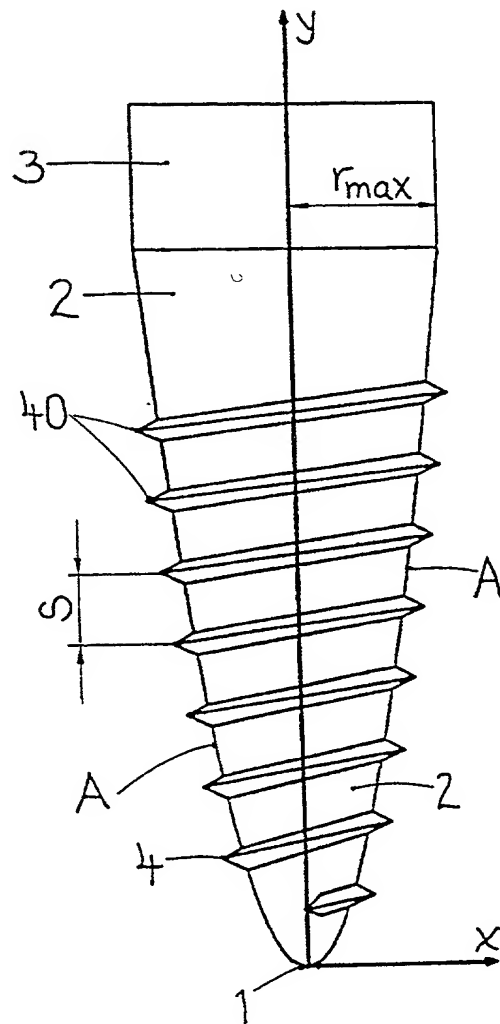Leydig, Voit & Mayer, Ltd.   202-737-6770

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Fig. 1

Fig. 2

Fig. 3

Attorney Docket No. _____

COMBINED DECLARATION AND POWER OF ATTORNEY

This declaration is of the following type:

- ☐ original ☐ design ☐ supplemental
- ☒ national stage of PCT
- ☐ divisional ☐ continuation ☐ continuation-in-part

As a below named inventor, I hereby declare that

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SCREW-TYPE INTRAOSSAL DENTAL IMPLANT

the specification of which:

- ☐ is attached hereto.
- ☐ was filed on _____ as Serial No. _____ and was amended on _____ (if applicable).
- ☒ was described and claimed in PCT International Application No. PCT/ CH99/00452 filed on 22 September 1999 and as amended pursuant to PCT Article 19 on _____ (if any).

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information that is material to the examination of the application identified above in accordance with 37 CFR §1.56.

I claim foreign priority benefits pursuant to 35 USC §119(a) of any foreign application(s) for patent or inventor's certificate or of any PCT international patent application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent, utility model, design registration, or inventor's certificate or any PCT international patent application(s) designating at least one country other than the United States of America filed by me for the same invention and having a filing date before that of the application(s) from which the benefit of priority is claimed.

PRIOR FOREIGN PATENT, UTILITY MODEL, AND DESIGN REGISTRATION APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC §119(a)						
COUNTRY	PRIOR FOREIGN APPLICATION	DATE OF FILING (day,month,year)	PRIORITY CLAIMED UNDER 35 USC §119(a)			
			YES		NO	
			YES		NO	
			YES		NO	

I claim the benefit pursuant to 35 USC §119(e) of the following United States provisional patent application(s):

PRIOR U.S. PROVISIONAL PATENT APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC §119(e)	
APPLICATION NO.	DATE OF FILING (day,month,year)

I claim the benefit pursuant to 35 USC §120 of any United States patent application(s) or PCT international patent application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this patent application is not disclosed in the prior patent application(s) in the manner provided by the first paragraph of 35 USC §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56 effective between the filing date of the prior patent application(s) and the national or PCT international filing date of this patent application.

PRIOR U.S. PATENT APPLICATIONS OR PCT INTERNATIONAL PATENT APPLICATIONS DESIGNATING THE U.S., BENEFIT CLAIMED UNDER 35 USC §120				
U.S. PATENT APPLICATIONS		Status (check one)		
SERIAL NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED
1.				
2.				
3.				
PCT APPLICATIONS DESIGNATING THE U.S.			Status (check one)	
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NOS. ASSIGNED (if any) / PATENTED	PENDING	ABANDONED
4.				
5.				
6.				

As a named inventor, I appoint the following attorneys to prosecute this application and transact all business in the Patent and Trademark Office connected with this patent application.

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I authorize my attorneys to accept and follow instructions from _____ regarding any matter related to the preparation, examination, grant, and maintenance of the patent application identified above, any continuation, continuation-in-part, or divisional patent application based on the patent application identified above, and any patent issuing from that patent application, until I or my assigns withdraw this authorization in writing.

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Residence:

Post Office Address:

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Inventor's signature _____

Date _____   Country of Citizenship:

Residence:

Post Office Address:

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